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Present status of direct heating experiments of counter illuminated imploded core using GXII/LFEX

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Fast ignition (FI) is an advanced ignition scheme on Inertial Confinement Fusion. The FI can separate implosion and ignition process that contributing relaxation of implosion symmetry that required for central ignition scheme now National Ignition Facility has involved in.

We have applied FI to realize laser fusion mini-reactor CANDY that demonstrates electricity generation from laser-induced fusion neutrons driven by 10 Hz, kJ laser [1]. Toward the CANDY, we have conducted counter illuminating FI experiments [2, 3, 4] with utilizing 1-10 Hz joule-class laser HAMA [5]. In the counter illuminating FI, an imploded core is directly illuminated by ultra-intense laser pulse. The key issue is clarification of energy coupling scaling from the laser to the imploded core via laser-produced hot electron or fast ions.

To clarify the scaling of heating efficiency on Fast Ignition (FI) scheme for direct illuminating configuration, we have conducted single-shot laser experiments utilizing GXII/LFEX laser system with collaboration of ILE, Osaka University. On the previous experiments, utilizing 2-beam LFEX, a promising result for direct illumination on FI has been obtained that represented contribution of fast ion for plasma heating [6, 7]. In this presentation, we present recent experiments utilizing 4 beam LFEX.

Experiments are performed with two laser beam illuminating configurations called (i) Axial and (ii) Transverse. Figure 1 shows the beam configurations. The

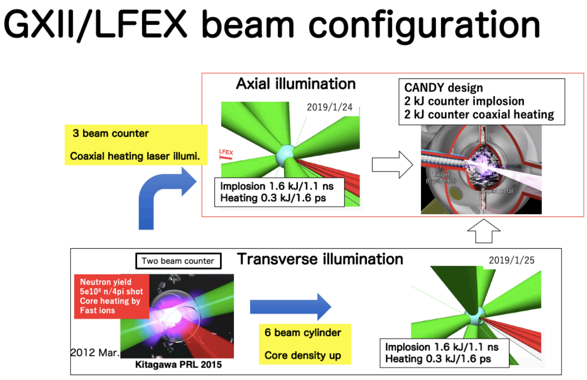

Figure 1: Illuminating beam configurations: (i) Axial, (ii) Transverse.

target is a spherical deuterated styrene shell with diameter of 500 μm and thickness of 7 μm. 6 beams of GXII green pulses (1.1 kJ/1.1 ns) were used for imploding the shell and 4 beams of LFEX IR pulses (0.3 kJ/1.6 ps) were used for heating the imploded core. Characteristics of imploded core and heating of the core were evaluated from x-ray emissions taken by x-ray pinhole camera and x-ray streak camera [8]. Those images were simulated by two-dimensional radiation-hydrodynamic simulation code STAR2D [9]. Neutron signals [10], fast electron energy spectrometer and ion track detector CR39 were also installed.

From the experiments and evaluations, transverse illumination indicated more efficient than axial illumination. Followings are summary of results:

Axial illumination

Core plasma density: $\rho = 2.8\ (1\pm0.14)$ g/cc

Core radius: $R_Z = 56$ μm, $R_x = 38$ μm, $R_y = 37$ μm

Areal density: $\rho R = 0.016(1\pm0.14)$ g cm^{-2}

Core temperature (implosion): 0.7 keV

Incremental of core temperature with heating: 0.1 keV

Transverse illumination

Core plasma density: $\rho = 1.9\ (1\pm0.14)$ g/cc

Core radius: $R_Z = 32$ μm, $R_x = 81$ μm, $R_y = 41$ μm

Areal density: ρR unknown

Core temperature (implosion): 0.65 keV

Incremental of core temperature with heating: 0.2 keV

Note: LFEX beam is along the x-axis.

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